PATENT SPECIFICATION

641,199

Date of Application and filing Complete Specification: *Feb. 6, 1948.* *No. 3544/48.*

Application made in United States of America on Nov. 8, 1945.

Complete Specification Published: Aug. 9, 1950.

(*Under Rule 17a of the Patents Rules 1939-47, the proviso to Section 91 (4) of the Patents and Designs Acts, 1907 to 1946, became operative on Feb. 6, 1948.*)

Index at Acceptance:—**Class 40(vii)**, AE3w, AE4(a2x : p2), AE6(c : fx).

COMPLETE SPECIFICATION.

Antenna.

We, STANDARD TELEPHONES AND CABLES LIMITED, a British Company, of Connaught House, 63 Aldwych, London, W.C.2., England, Assignees of FRANK JOEL LUNDBERG, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to antennas and more particularly to wide band antennas having a consistent, desired radiation pattern over a considerable range of frequencies.

In certain applications of the radio communications art, such as direction finding, it is frequently necessary to employ two or more antennas in fairly close proximity to one another. Under such circumstances, the mutual interaction of the radiation of one antenna with respect to an adjacent one is undesirable.

It is an object of the present invention to provide an antenna which causes a consistent radiation pattern to be established over a wide range of frequencies.

It is another object to provide an antenna which has a radiation pattern extending straight ahead of the antenna and covers substantially a 45° range on each side of the center line of the pattern.

It is a further object to provide an antenna which causes the establishment of a substantially spherical, strictly defined and forwardly-directed radiation pattern.

It is another object to provide an antenna which has a radiation pattern characteristic which permits of the use of more than one antenna in relatively close proximity to one another without mutual disturbances.

According to the present invention there is provided an antenna comprising a pair of flat conducting members disposed in one plane and spaced to form a gap therebetween, transmission lines arranged to feed energy to said flat members at opposite sides of said gap, and a radiating member conductively connecting the two furthest opposite edge portions of said flat members and having a contour which is at least a part of a semi-circle in a plane perpendicular to that of said flat members; preferably this contour has a length of .59 wavelength. The flat conducting member may serve as a matching network for the transmission line to hold the impedance presented thereto constant within a two-to-one ratio for a frequency band of three-to-one for the antenna. The radiating member may take the form of a hemisphere having its base in the plane of said flat members and having portions cut away at opposite ends of a diameter through the gap. A reflecting member may be provided spaced adjacent and parallel to said flat members.

There is also provided an antenna array comprising two antennas, each as outlined in the preceding paragraph, disposed side by side and arranged to provide mutually non-interfering radiation patterns in a given direction.

The invention will be best understood from the following description of an embodiment thereof, reference being had to the accompanying drawings, in which:

Fig. 1 is a top, plan view of the antenna in accordance with the invention;

Fig. 2 is a sectional view of the antenna taken on line 2—2 of Fig. 1;

Fig. 3 is a horizontal plan view, in polar co-ordinates, of typical radiation field pattern curves obtained from an antenna as in Figs. 1 and 2 when mounted vertically;

Fig. 3A is a top plan view of an antenna as used to produce the pattern of Fig. 3;

Fig. 4 is a view illustrating the use of two antennas of the invention having radiation patterns similar to those of Fig. 3; and

Fig. 5 is a perspective view of an alternative form for the antenna.

Referring now to the drawings, the antenna shown in Figs. 1 and 2 consists of a basic hemisphere 1 which has been partly cut away at the two opposite portions thereof as indicated at 2 and 3, the resulting openings

[*Price* 2/-]

4 assuming a somewhat paraboloid form as might be obtained at the line of intersection between a hemisphere and a cylinder, with their major axes substantially parallel. The hemisphere, which is the radiator portion of the antenna, is fed from a transmission line 5 and 6 connected to two sides 7 and 8 of a gap 9 formed between two flat plates 10 and 11. These plates 10 and 11 are disposed in the plane of the base of the hemisphere and constitute a network which is matched to the characteristic impedance of the transmission line 5, 6. To provide a forwardly and uni-directional pattern, a reflector 12 in parallel relationship to the feeding plates 10 and 11 is used.

The character of the two feed plates is preferably such that within a 3-to-1 frequency band ratio, the impedance presented to the transmission line falls within a 2-to-1 ratio. This may be approximated by making the radius r of the cut of each of the feed plates substantially equal to the width of the waist w of the radiator. In order to attain the desired consistent pattern over a wide range of frequencies, it will be required to dimension the hemisphere such as to make the great circle portion of the contour of the radiating member 1 between the flat plates 10 and 11 equal to a 0.59 wavelength at the mid-frequency. This will insure that a maximum current distribution will be maintained at all times over the top or forward section of the hemisphere indicated by 13.

Theoretical analysis of the optimum proportioning of an antenna shows that the diameter of the hemisphere should approximate $\frac{3}{8}$ of a wavelength at the mid frequency of the band, the width of the waist w being about $\frac{1}{8}$ of a wavelength and the width WF of the flat plates at their points of meeting with the radiator about $\frac{5}{16}$ of a wavelength. The spacing of the reflector 12 from the base of the radiator is preferably about $\frac{1}{8}$ of a wavelength. An antenna of this type is productive of radiation patterns for various frequencies substantially as shown by the curves in Fig. 3, the significant characteristic being that the main strength is substantially confined within a 45° range on either side of the center line of the pattern. There is however considerable latitude in the proportioning, the patterns reproduced by the curves in Fig. 3 being actually obtained with an experimental antenna which had the diameter of four inches, the reflector being spaced two inches from the radiator base. Field patterns for six frequencies as indicated were obtained. The antenna was positioned for vertical polarization and was made directional by using a thirty six inch square reflector mounted two inches behind the radiator. Fig. 3A is a top plan view of the radiator member of this experimental antenna.

The view of Fig. 4 illustrates how two antennas may be used in fairly close proximity without causing intercoupling between the antennas. Since the radiation is substantially zero transversely of the array there will be practically no coupling therebetween. This type of application is of particular importance in direction finding.

The form of antenna shown in Fig. 5 utilizes for the radiating portion 1 a rectangular sheet of metal bent into a semicircle which is fed in accordance with the feeding method shown for the antenna of Fig. 1.

While a specific form of antenna has been shown, it should be noted that alternative forms are contemplated here. Other forms of cuts may be taken in the hemisphere which may be smaller or larger than the ones indicated and may possibly have somewhat different shapes. Other forms for the flat plates are also within the present scope. It is also clear that, if desired, instead of using a complete hemisphere, as shown, a smaller segment of the sphere may be used, provided that the great circle requirement of .59λ is met for the radiating member.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is :—

1. A radio antenna comprising a pair of flat conducting members disposed in one plane and spaced to form a gap therebetween, transmission line means arranged to feed energy to said flat members at opposite sides of said gap, and a radiating member conductively connecting the two furthest opposite edge portions of said flat members and having a contour which is at least a part of a semicircle in a plane perpendicular to that of said flat members.

2. An antenna according to Claim 1 wherein said flat members function as a matching network for said transmission line, the impedance presented by said network remaining within a two-to-one ratio for a frequency band ratio of three-to-one for the antenna.

3. An antenna according to Claim 1 wherein the great circle portion of the contour of said radiating member comprises substantially 0.59 wavelength between said flat members.

4. An antenna comprising a pair of flat conducting members disposed in one plane forming a gap therebetween, transmission line means arranged to feed energy to said flat members at opposite sides of said gap, and a radiating member conductively connecting the two furthest opposite edge portions of said flat members and comprising a hemispherical portion, the base of which

is in the plane of said flat members, and has portions cut-away at opposite ends of a diameter through said gap.

5. An antenna according to Claim 4 wherein said two cut-away portions are such as would be determined by the lines of intersection between said hemisphere and two cylinders.

6. An antenna according to Claim 4 wherein said two cut-away portions are such as would be determined by the lines of intersection between said hemisphere and two cylinders, the axes of said hemisphere and said cylinders being substantially parallel.

7. An antenna according to Claim 4 wherein said flat conductive members have a portion of their outside edges meet with the hemisphere, the remaining inside edge portions thereof being obtained by a cut having a radius substantially equal to the narrow portion of the hemisphere between the two cut-away portions.

8. An antenna according to Claim 4, wherein said flat members function as a matching network for said transmission line, the impedance presented by said network remaining within a two-to-one ratio for a frequency band ratio of three-to-one for the antenna.

9. An antenna according to Claim 4, further including a reflecting member spaced adjacent and parallel to said flat members.

10. An antenna array comprising at least two antennas disposed substantially side-by-side and arranged to produce mutually non-interfering radiation patterns in a given direction, each comprising: a pair of flat conducting members disposed in one plane and spaced to form a gap therebetween, transmission line means arranged to feed energy to said flat members at opposite sides of said gap, and a radiating member conductively connecting the two furthest opposite edge portions of said flat members and having a coutour which is at least a part of a semi-circle in a plane perpendicular to that of said flat members, whereby substantially zero radiation will be obtained transversely of the array.

11. An antenna array comprising at least two antennas disposed substantially side-by-side and arranged to produce mutually non-interfering radiation patterns in a given direction, each comprising: a pair of flat conducting members disposed in one plane forming a gap therebetween, transmission line means arranged to feed energy to said flat members at opposite sides of said gap, and a radiating member conductively connecting the two furthest opposite edge portions of said flat members comprising a hemispherical portion, the base of which is in the plane of said flat members and has portions cut away at opposite ends of a diameter through said gap, whereby substantially zero radiation will be obtained transversely of the array.

12. An array according to Claim 11, further including for each of said antennas a reflecting member spaced adjacent and parallel to said flat members.

Dated this 6th day of February, 1948.

ERNEST E. TOWLER,
Chartered Patent Agent,
For the Applicants.

Abingdon : Printed for His Majesty's Stationery Office, by Burgess & Son (Abingdon). Ltd.—1950.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies, price 2s. 0d. each (inland) 2s. 1d. (abroad) may be obtained.

FIG. 1.

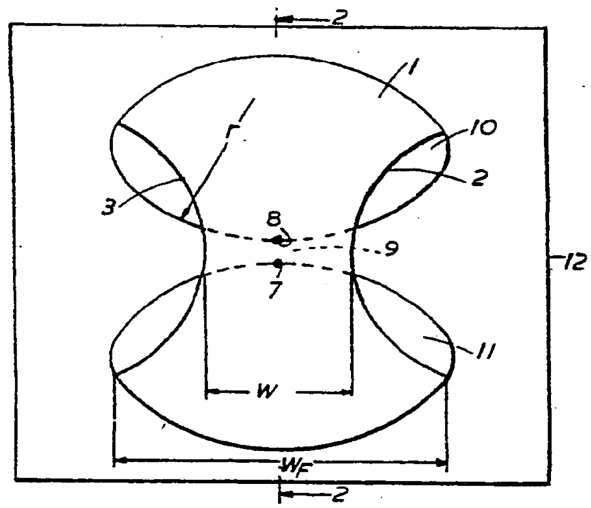


FIG. 2.

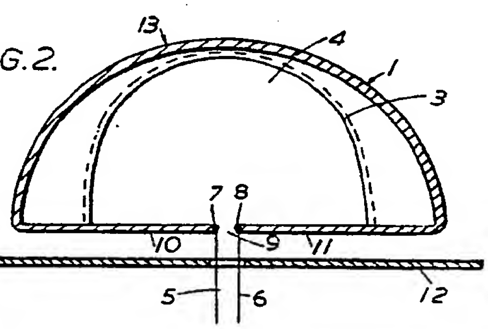
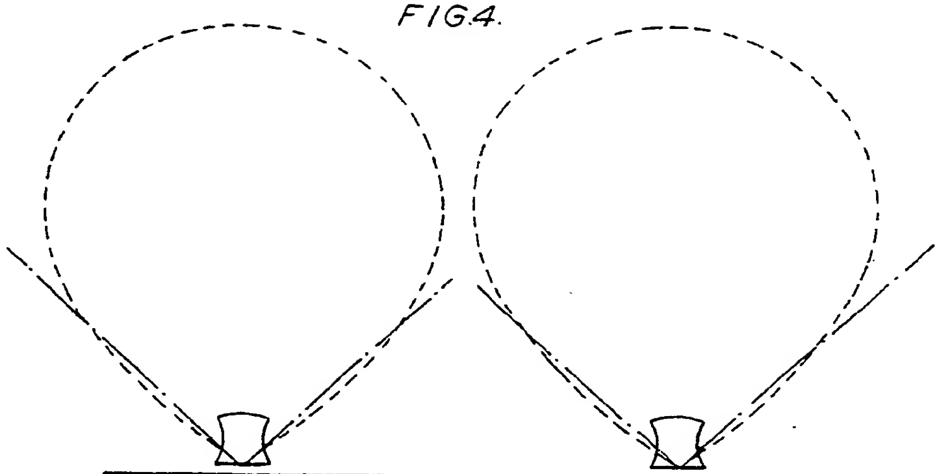


FIG. 4.



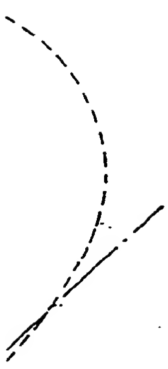


FIG. 3.

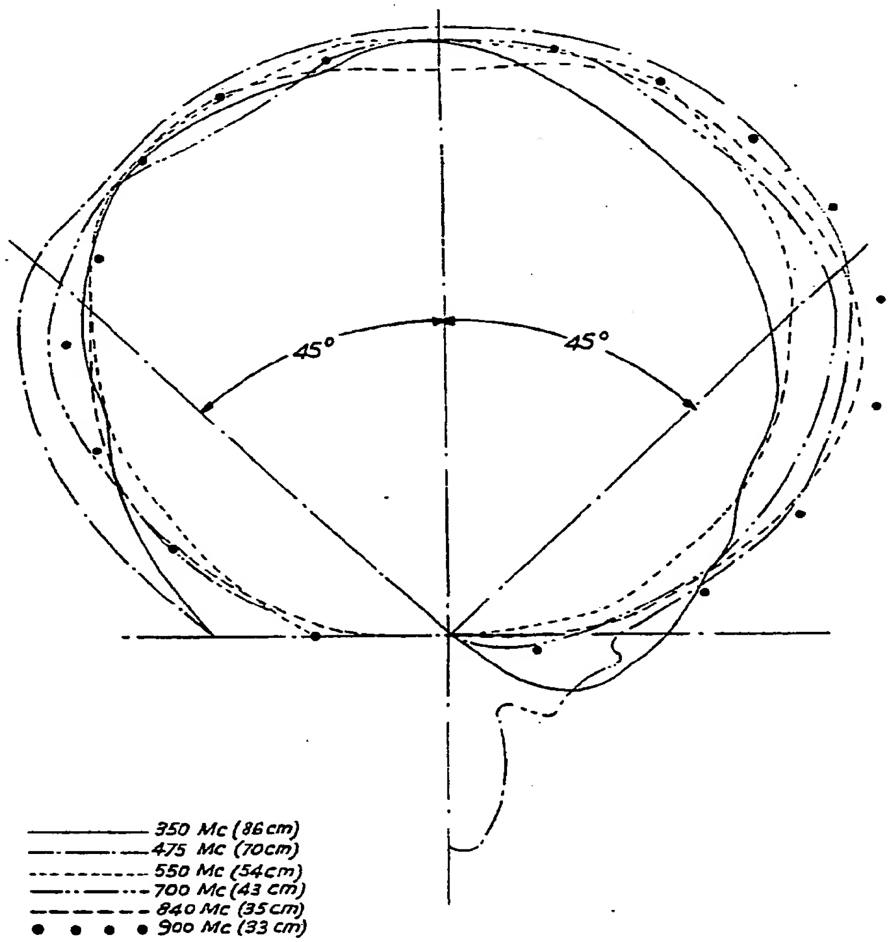
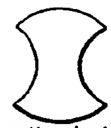
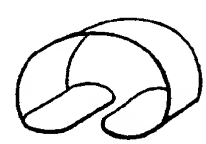


FIG. 3A.



4" diameter Hemisphere mounted 2" from 36" Reflector Sheet.

FIG. 5.



SHEET 1

FIG. 1.

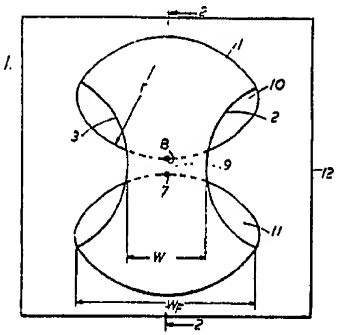


FIG. 2.

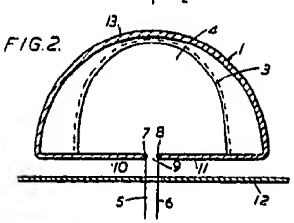
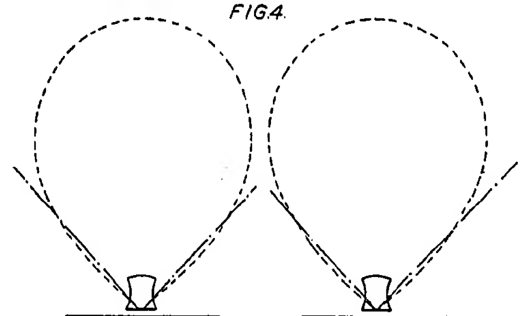


FIG. 4.



SHEET 2

FIG. 3.

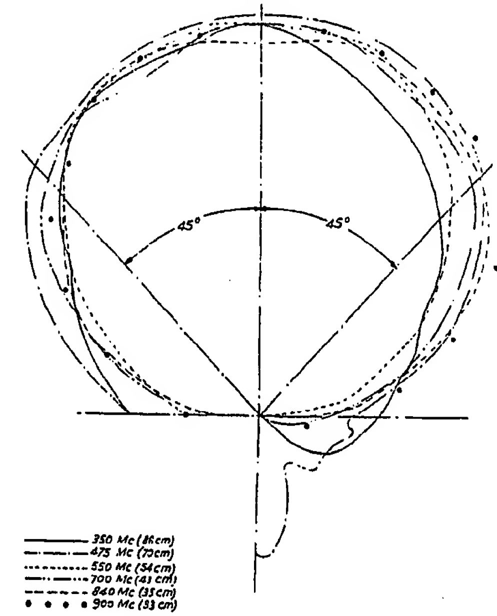


FIG. 3A.

4" diameter Hemisphere mounted 3" from 86" Reflector Sheet.

FIG. 5.

[This Drawing is a reproduction of the Original on a reduced scale.]